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Productivity of R&D institution: The case of Indonesia

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ABSTRACT

This study analyzes the performance of Indonesian R&D institutions based on R&D productivity. By applying an institutional approach, the effects of collective determinants such as quality of researcher, R&D budgets, locations and ages of R&D institutions on productivity are considered. Our findings show that these performance variables had strong and significant effects on R&D productivity. A national innovation system should be developed in developing countries with different models from those used in developed countries. The non-economic dimension is essential in developing national innovation systems in developing countries such as Indonesia.

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1. Introduction

Empirical studies that analyze the productivity of R&D institutions, including their strengths and other factors, are limited for developing countries. This paper addresses the productivity of R&D institutions in Indonesia as an example of developing country, based on an institutional approach [14,5,30,38]. The study also analyzes these institutions' important collective determinants. In this case, we introduce technological and disseminating productivity in addition to scientific (publication) productivity. In terms of disseminating productivity, this indicator measures the capacity of R&D institutions to develop new technology that can be applied to society, whether for commercial or non-commercial use. That is, this indicator can measure the relevance of R&D activities to the social and economic contexts of the society. From this point of view, disseminating productivity is a more comprehensive indicator of the performance of R&D institutions.

A previous study compared and analyzed the performance of Indonesian R&D institutions based on scientific as well as technological productivity [35]. The effects of the type of R&D institution and their funding sources on productivity were considered. Based on their funding sources, the previous results showed that the R&D institutions with self-sufficient funding had better performance than did government-funded institutions. In accordance with their mandates, the state-owned enterprise R&D institutions were the most productive R, followed by ministerial R&D agencies and non-ministerial government research institutes, especially based on technological productivity.

This study built on the findings of the previous research mentioned above. Based on an institutional approach rather than the individual performances of researchers, this study focused on the effects of certain collective determinants on R&D productivity, such as researcher quality, R&D budget, location and age of institution, that were excluded from the previous study. More detailed analysis of the collective factors that contribute to innovation and research success in Indonesia was conducted based on MLG (multiple linear regression) statistical analysis.

This paper aims to contribute to the empirical evidence for the effects of the above determinants to the R&D productivity in developing countries such as Indonesia. The policy recommendations that are formulated in this paper are a next-step objective for improving the performance of R&D institutions in Indonesia.

2. R&D productivity

2.1. Institutional approach

The scientific productivity of researchers, which is used to measure the performance of scientific institutions, has been studied by many authors. The important determinants have been discussed, such as age, gender, type of position occupied by scholars, scientific discipline, training, average ages and positions of

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colleagues, the quality of institutions and colleagues, non-permanent researchers, size of institutions, funding, scientific collaboration, etc. [2,3,10,11,9,7,46].

However, there are two important notes, from our perspective, that should be discussed related to the debate on performance indicators for R&D institutions, especially in developing countries. First, the determinants and methodological approach that were adopted in the above productivity studies are more individually oriented. Indeed, the performance of R&D institutions can be evaluated by researcher productivity individually, but this approach is just one option.

Another option is a methodological approach based on the institution rather than the personal performance of the researchers, in which the performance of the R&D institution is evaluated based on institutional output or outcome indicators such as: efficiency, productivity, relevance, etc. A number of researchers had applied the institutional approach at the laboratory level in this field [9–11], as well as at the institutional level [2,4]. Some scholars suggest that further investigation of academic research production should take into account regarding the collective levels of organizations, such as in the institutional European context and at the laboratory level [17,42]. The results at a collective level may be quite different from the results for individual researchers, especially due to important externalities among researchers within labs, such as critical knowledge spillovers, reputation, sharing of equipment and facilities, complementarities between different types of researchers, or even different research agendas [10].

Second, scientific publications can measure the performance of R&D institutions—especially HEIs (higher education institutions)—that are weighted in basic research to provide proof of concept. However, for institutions that conduct applied research as well as experimental development on the downstream side, indicators such as patents, new technology, technical recommendations, and newly adopted technology are more favorable indicators. On the other side, international publications in developing countries still suffer from some constraints. For example, topics in international journals are less focused than are those in the developed world; there is limited access to researchers from developing countries for international journals; different languages and cultures, etc. [7]. Although bibliometric techniques result in generally valid and reliable estimates of productivity, they prove inadequate in studying scientific activity in developing countries because the scientific outputs of the developing world are not well represented in international scientific databases, reflecting differences in priorities in terms of local needs and global thematic interests [46]. On the one hand, the focus on scientific papers of analyzing research productivity is narrow. The essence of a researcher in a public research organization is not necessarily to publish papers per se but to produce and communicate knowledge through different mechanisms. Ref. [21] show that researchers in the agricultural sector produce three main types of outputs: 22.9% produce only papers, 23.7% only new recommendations and techniques, and 65.6% produce more than one output, of whom, 53.4% produce papers and other outputs. Hence, an analysis of papers does not allow for a broader measure of research productivity [21].

2.2. The collective determinants

The main studies by various authors on the collective determinants of R&D productivity are presented in Table 1. According to this table, an important collective factor that affects productivity in R&D institution is, first, the size of the institution. Ref. [4] found that size of the institution was never positively correlated with productivity. In nearly all fields, the most productive labs are the small ones, and the least productive ones may be large; in general, there is no positive relationship between size and productivity. Although the most productive institutes are likely to be found in smaller classes, the least productive are spread across classes of all sizes. Interestingly, the distributions of cost per publication and cost per international publication are again highly skewed. It is interesting to check whether the highly productive institutes are also those that spend more per publication. Clearly, if such a relationship held, a possible explanation for higher productivity would not lie in organizational factors or in the quality of the scientific environment but rather in greater access to funds, complementary personnel, or external resources. This study will check this relationship and demonstrate that determinants of R&D productivity mainly do not lie in greater access to funds, complementary personnel, or external resources but rather in organizational factors or in the quality of the scientific environment.

[9] and [3] revealed similar results. In a sample of Spanish manufacturing firms, the effects of firm size on R&D productivity were studied. Individual researchers publish more in small labs, which seems to indicate that the size of the institution plays an important role in both the individual and collective performance of researchers. This could be explained by standard advantages linked to smaller size: lower coordination costs, quicker decision processes, lower administrative burden, etc. [9].

Another collective determinant is R&D funding. Ref. [15] showed that laboratory funding structure was strongly correlated with the nature of research and concluded that research productivity was influenced by this structure. Ref. [7] studied the impact of the S&T budget on R&D productivity. They believed that budget had an impact on overall productivity with a lag, although it was difficult to determine the duration of the lag. A similar result was obtained by Ref. [16]; who analyzed the standing of Italian science and its evolution over the last three decades compared with the main scientific producers in Europe and found that, in Italy, both the scientific production and its quality were highly correlated with government R&D expenditures and higher education sectors. They showed that even though the level of funding had been dramatically low during the past decades compared with most EU science producers, science in Italy was able to increase its performance through 2007. The funding source model is one important policy instrument. The direct funding of R&D is one of the main policy instruments used by governments to support science and innovation in their priority areas. As noted in the OECD innovation strategy, countries are restructuring and adapting their research financing mechanisms, for example, by creating new agencies that are responsible for allocating resources, making greater use of competitively awarded project funding than institutional funding, exploring how to tie funding more closely to specific objectives and missions, and increasing the focus on the quality and relevance of institutions' research activities in pursuit of excellence and economic and social impact [41]. Ref. [9] obtained similar results. They showed that public contractual funding has positive impacts on the scientific publication intensity at the laboratory level.

Management and leadership in scientific institutions are also important collective determinants. Ref. [40] studied the internal governance in German universities and found a positive effect of strong central leadership, operational flexibility, goal agreements, and an internal evaluation system. Ref. [18] followed up the recent interesting research from other sectors and showed that the leader (the CEO) matters significantly for organizational performance. He demonstrated that a university president who himself was an accomplished scholar had a significant positive effect on his university's overall research performance. Ref. [1] empirically examined the effect of management on academic research productivity in Australian universities. The results suggested that management practices indeed appeared to have some positive effects on research

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